Transverse Collins Asymmetry for Charged Hadrons

XII International Workshop on Deep Inelastic Scattering
Štrbské Pleso, High Tatras, Slovakia
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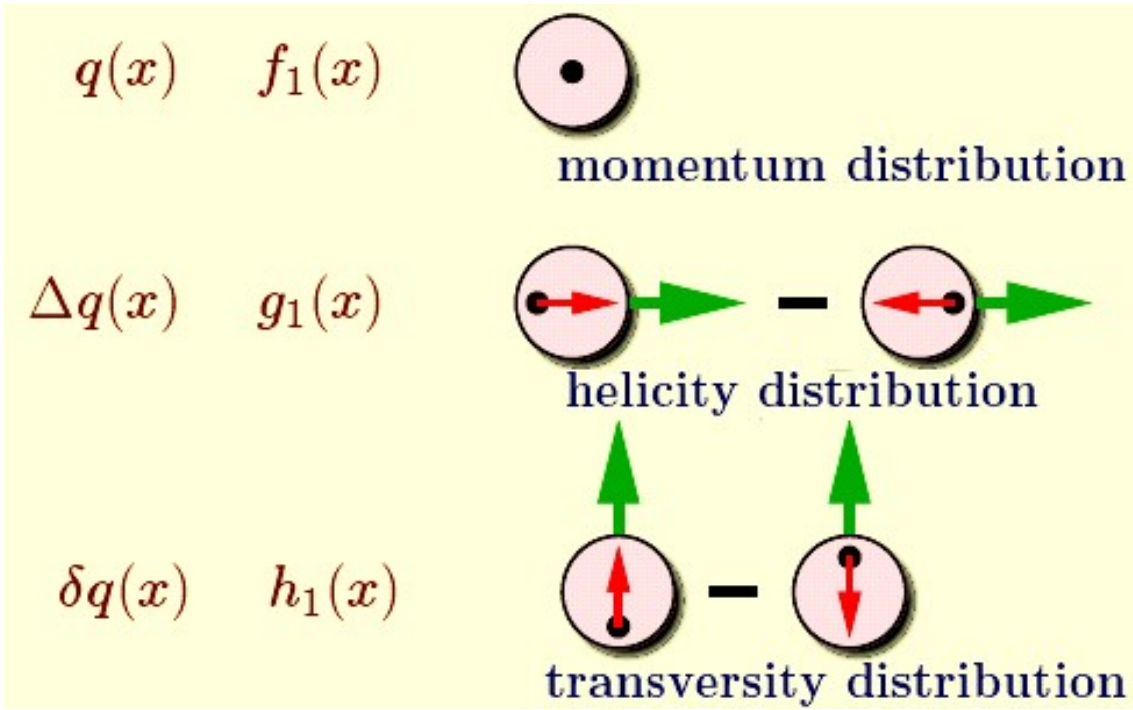
on behalf of the
COMPASS Collaboration

Motivation Data Analysis First Results

Transverse Spin Physics

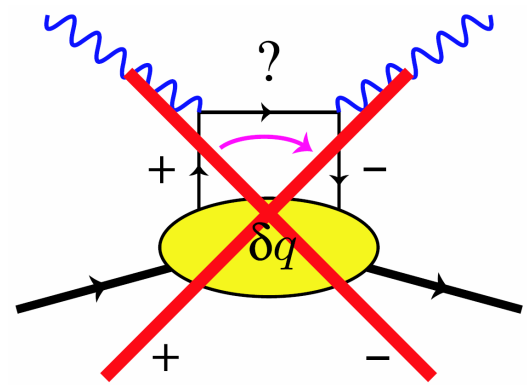
3 distribution functions are necessary to describe the spin structure of the nucleon at LO:



All of equal importance!

$h_1(x)$ decouples from leading twist DIS because helicity of quark must flip

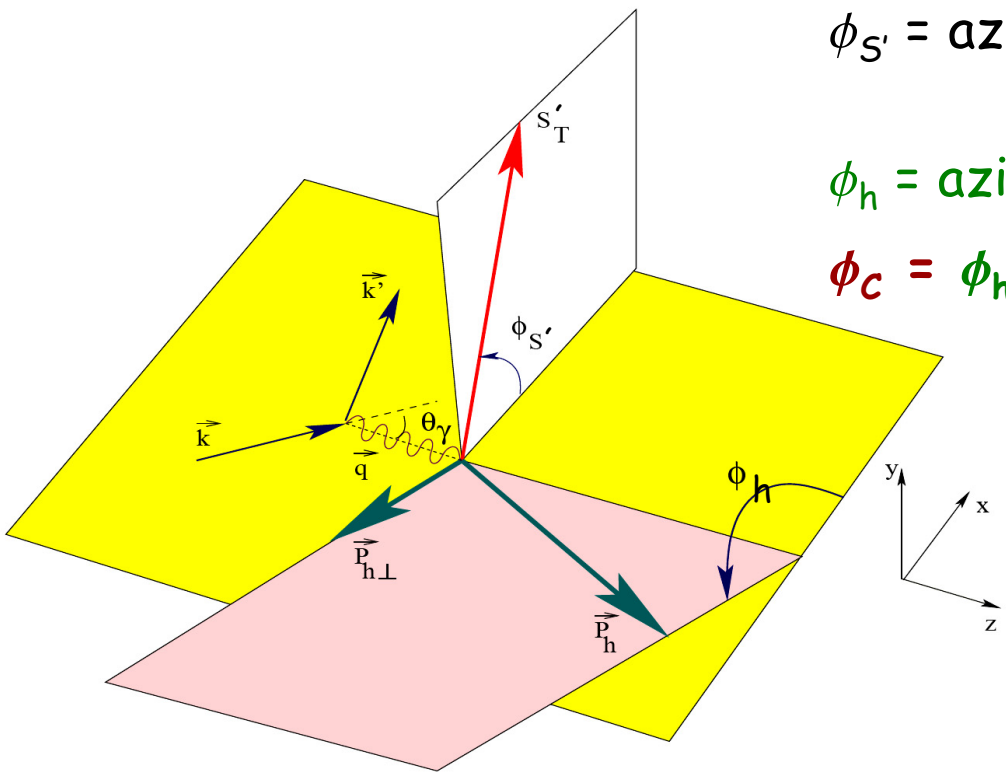
No mixture with Gluons in evolution - Valence like behavior



Transverse Spin Physics

3 possible quark polarimeters suggested:

- Measure transverse polarization of Λ
- Azimuthal dependence of the plane containing leading & next to leading hadrons
- Azimuthal distribution of leading π ← Results!



$\phi_{S'}$ = azimuthal angle of spin vector of **fragmenting** quark (after scattering)

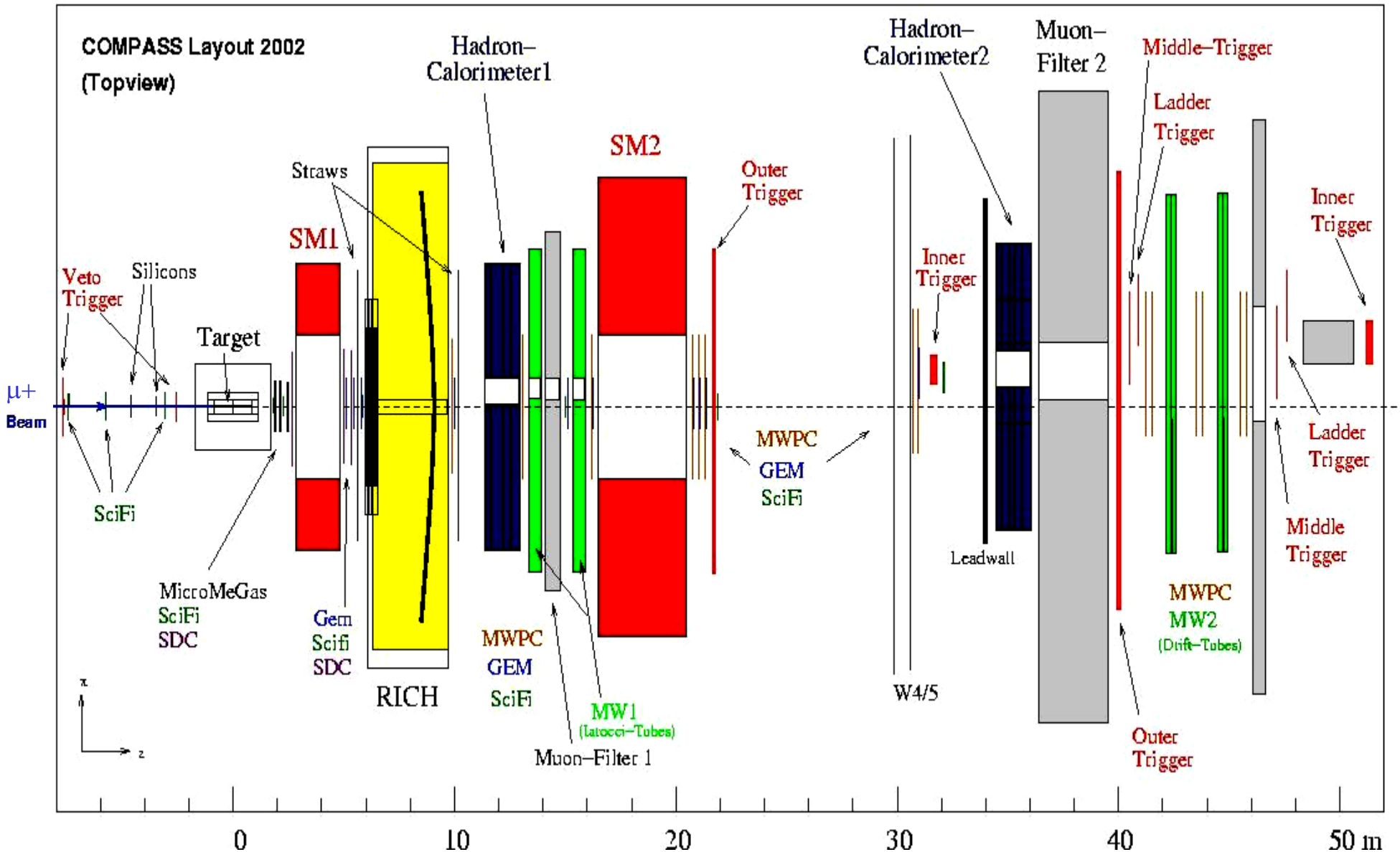
ϕ_h = azimuthal angle of hadron

$\phi_c = \phi_h - \phi_{S'}$

$$A_{Coll} = \frac{A_{UT}^{\sin\phi_c}}{D_{NN} \cdot f \cdot P} \quad !$$

$$\propto \frac{\sum_q e_q^2 h_1^q(x,Q^2) \cdot H_1^{\perp(1)q}(z,Q^2)}{\sum_q e_q^2 f_1^q(x,Q^2) \cdot D_1^q(z,Q^2)}$$

The COMPASS Experiment



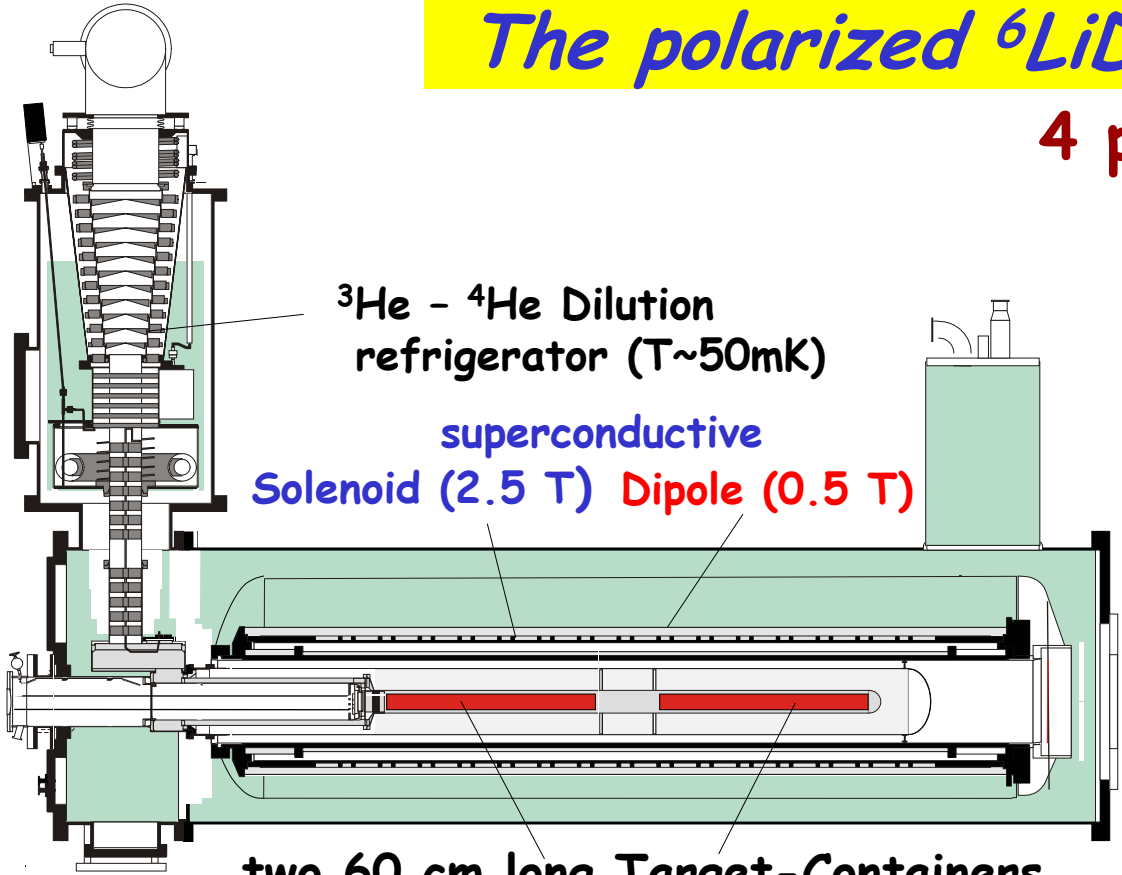
Beam: $2 \cdot 10^8$ μ^+/ spill (4.8s/16.2s)

Beam momentum: 160 GeV/c

Luminosity: ~$5 \cdot 10^{32}$ cm^{-2} s^{-1}

Beam polarization: -76%

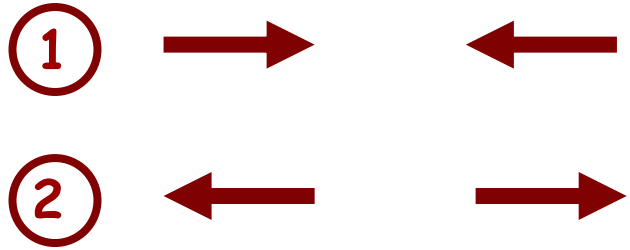
The polarized ^{6}LiD-Target



During data taking for transversity dipole field always ↥

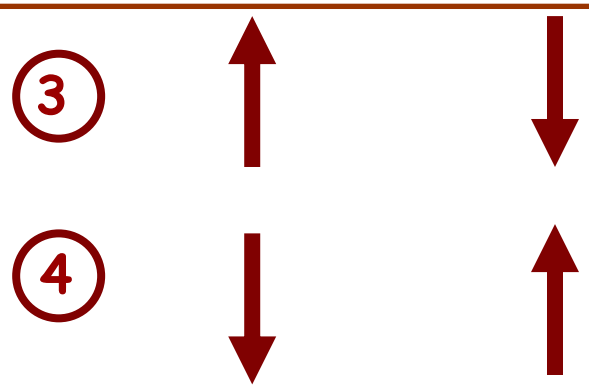
Relaxation time > 2000 hrs

4 possible spin combinations:



reversed every 8 hours

For transversity:

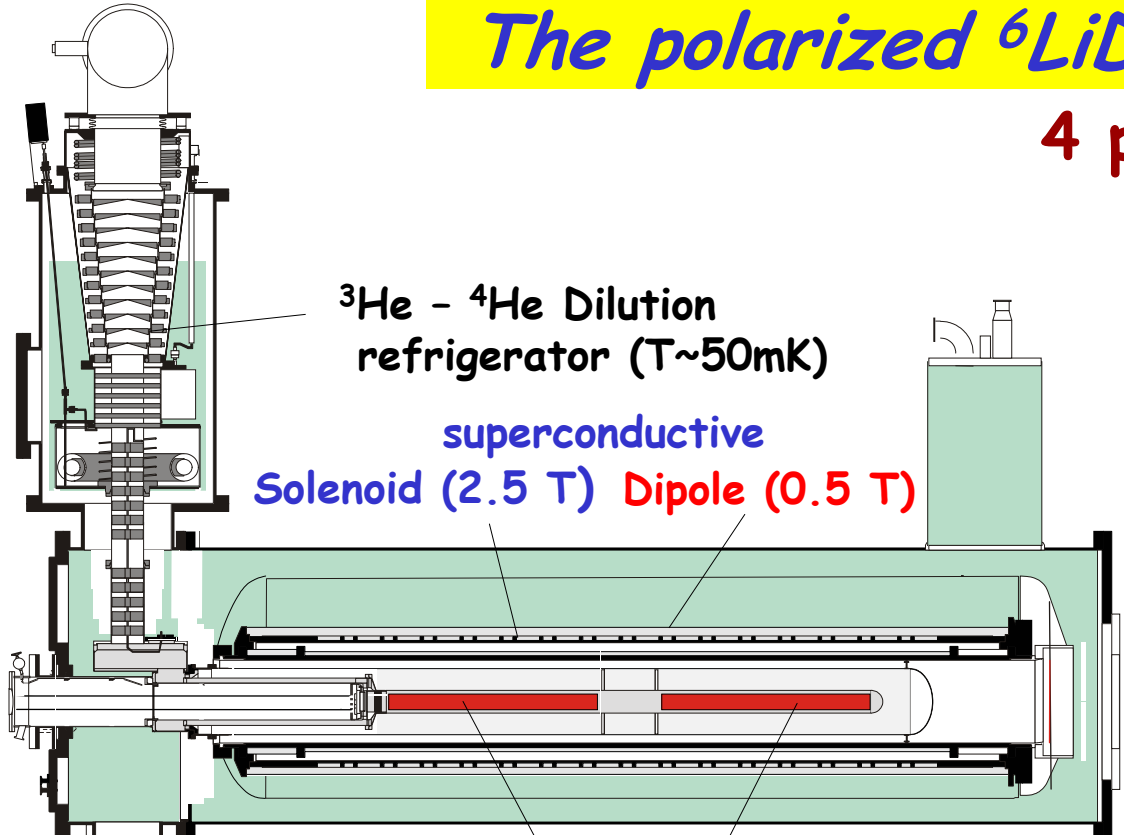


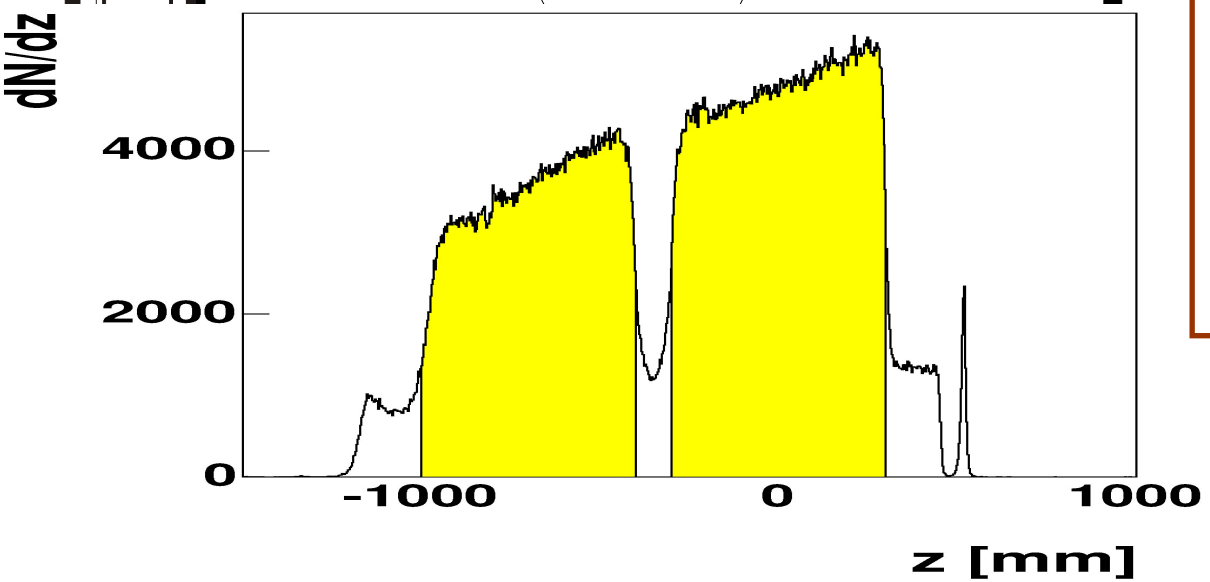
reversed once a week

Polarization: 50%

Dilution factor: 0.38

The polarized ^{6}LiD-Target





4 possible spin combinations:

① → ←

② ← →

reversed every 8 hours

For transversity:

③ ↑ ↓

④ ↓ ↑

reversed once a week

Polarization: 50%

Dilution factor: 0.38

Data Sample

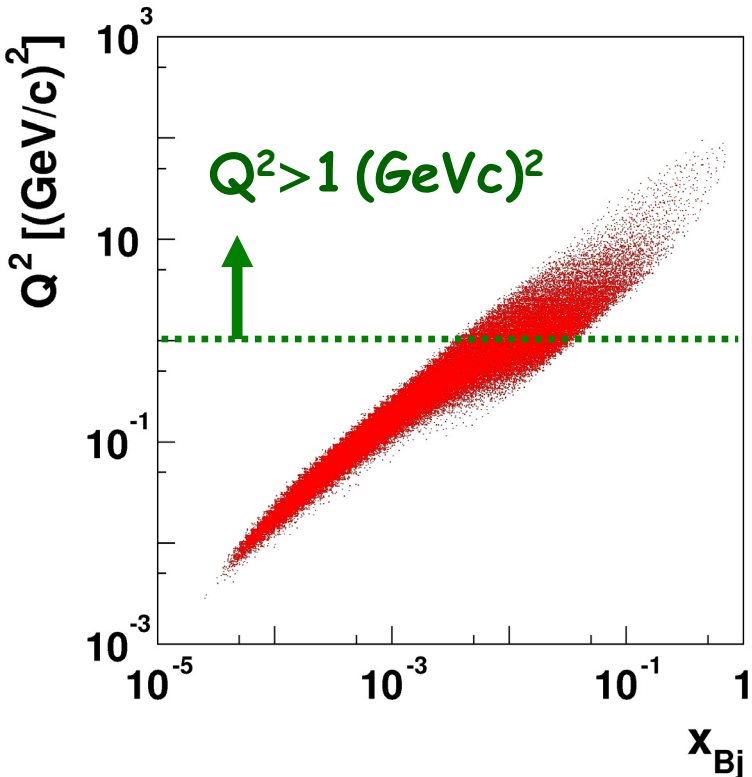
2002: 12+7 days of data taking (total)
with transversely polarized ^{6}LiD target
(separate analysis for both periods of data taking)

- $1.8*10^9$ events
- $1.6*10^6$ events after all cuts (preliminary)

2003: 2002 doubled;

2004 expected: 2002+2003

+ 2003 trigger upgrade
to gain sensitivity
on large x_{Bj} & large Q^2 events!

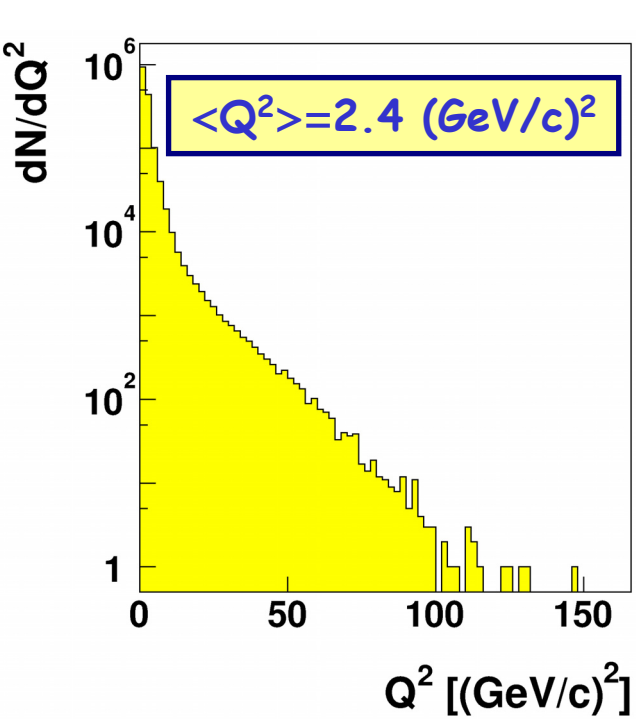


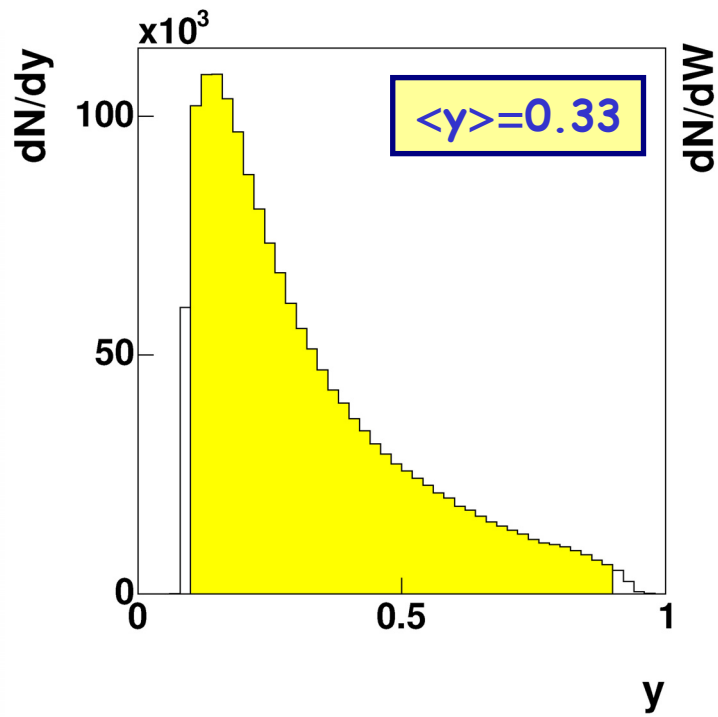
Event selection (1)

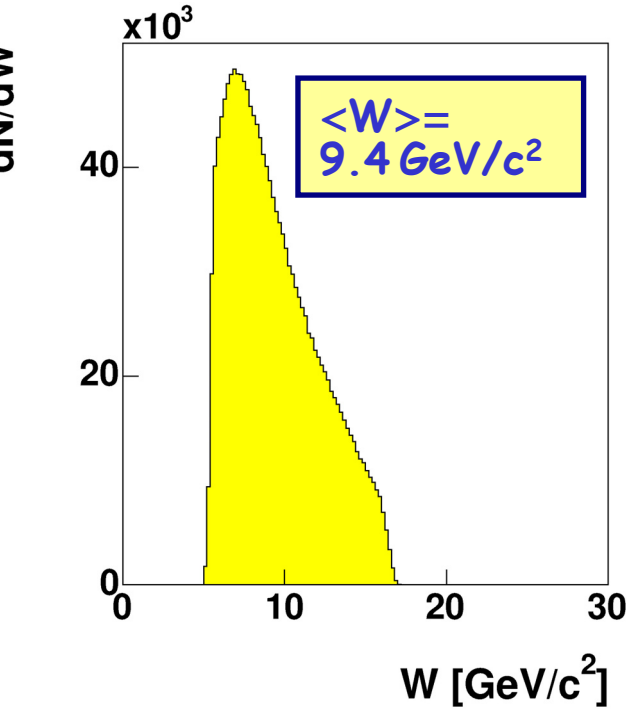
- Primary vertex with identified μ, μ' & hadron

Cuts on μ' based on kinematics:

- $Q^2 > 1\ (GeV/c)^2$
- $0.1 < y < 0.9$
- $W > 5\ GeV/c^2$







Event selection (2)

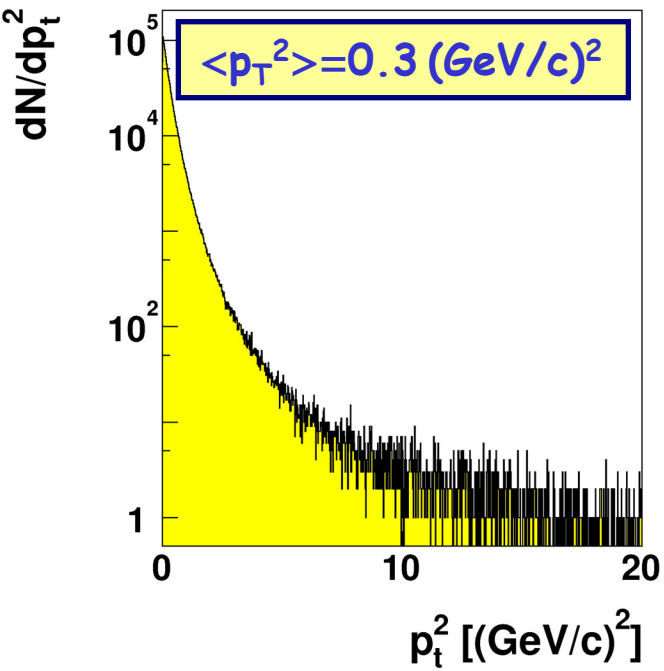
Leading hadron selection:

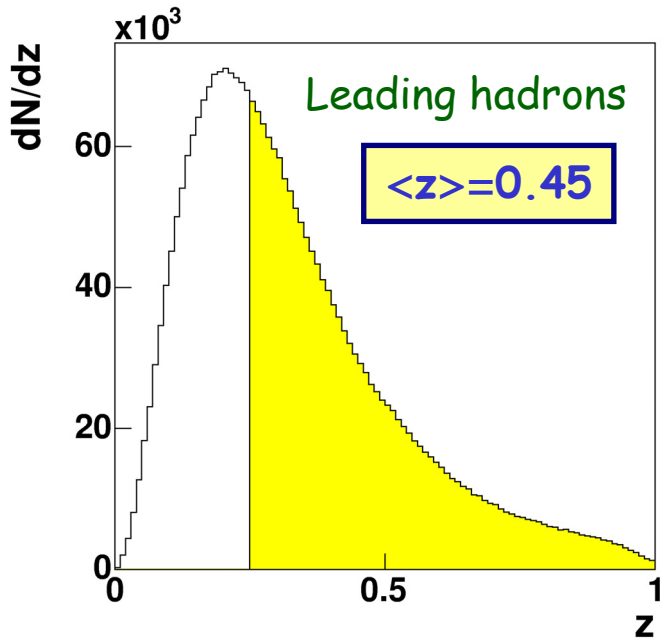
- energy deposit in hadron calorimeters > 5 GeV (HCAL 1)
  > 8 GeV (HCAL 2)
- Penetration < 10 X_0
- Presently no π / K / p separation by RICH

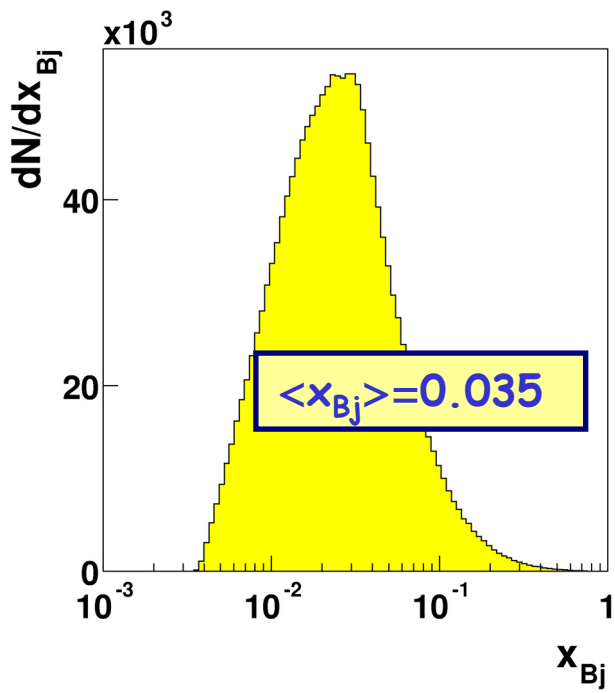
Cuts on leading hadrons based on kinematics:

- $p_T > 0.1$ GeV/c
- $z > 0.25$
- $z_{lh} > 1 - \Sigma z_i$

Final sample





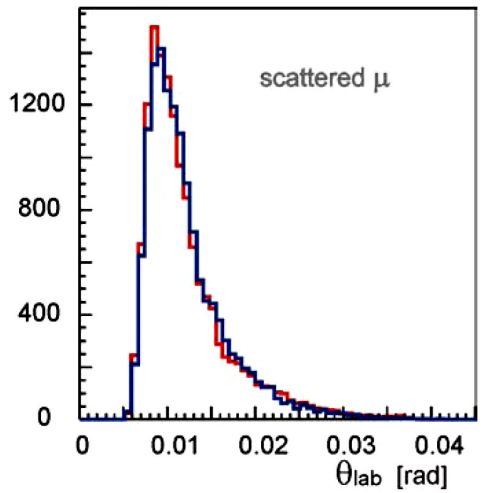


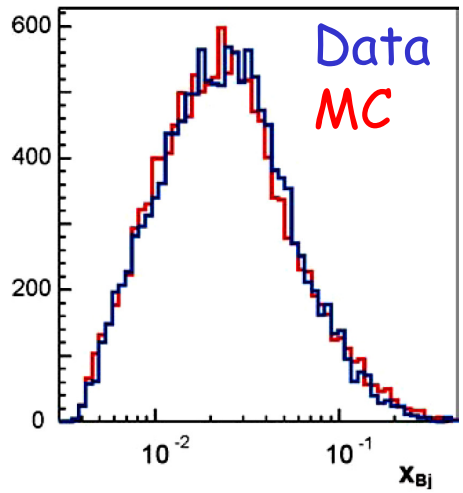
Monte Carlo studies (1)

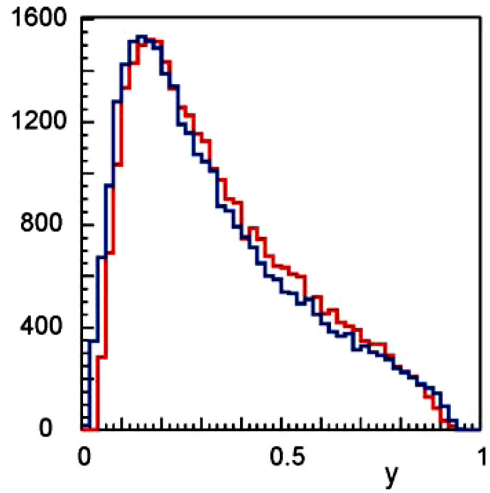
- MC events generated with Lepto 6.5.1

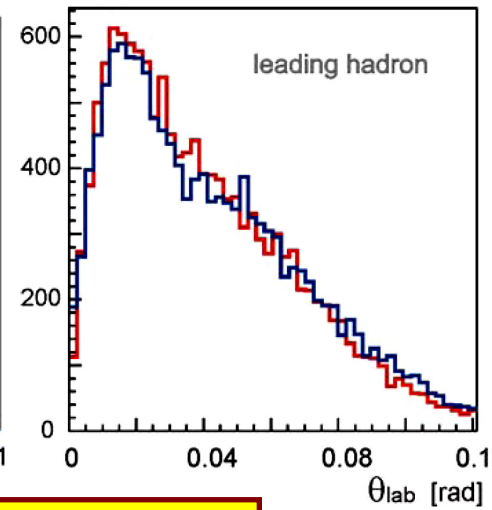
☑ Trigger geometry

☑ Tracking efficiencies

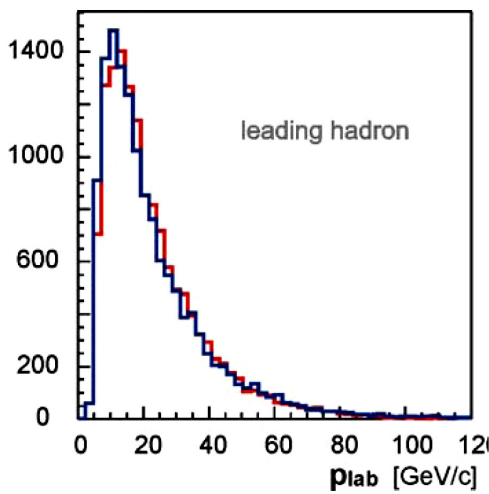


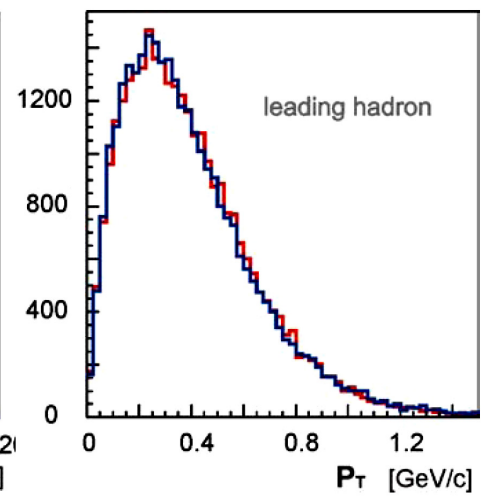


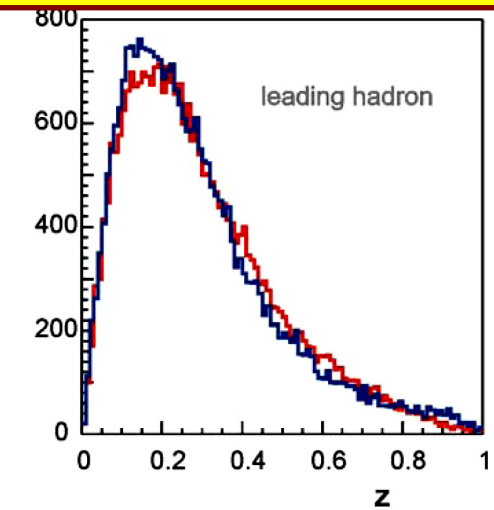


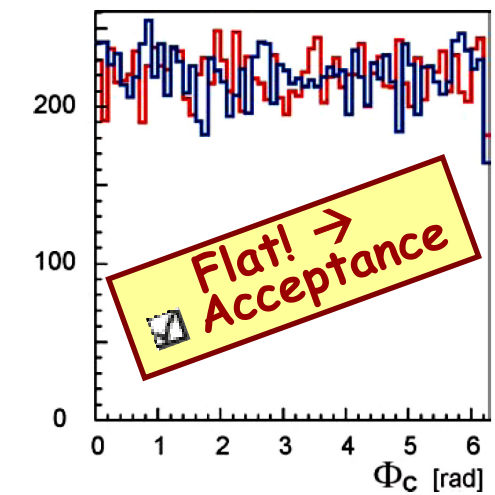


☑ **Overall good agreement between MC and real data**

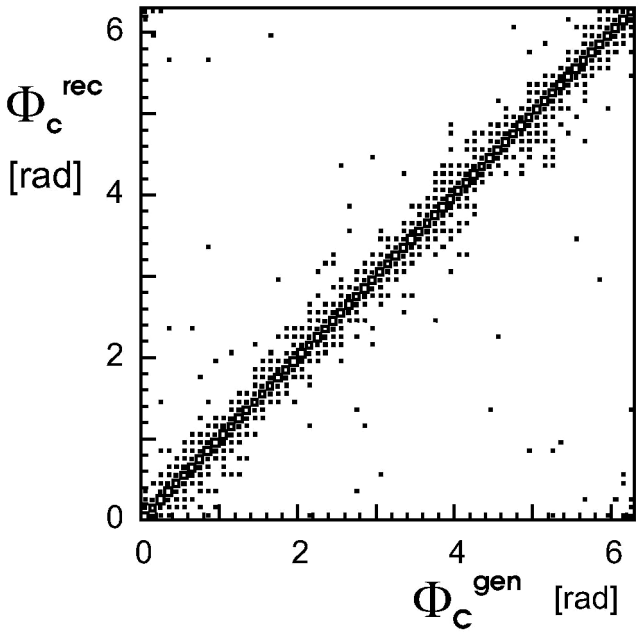


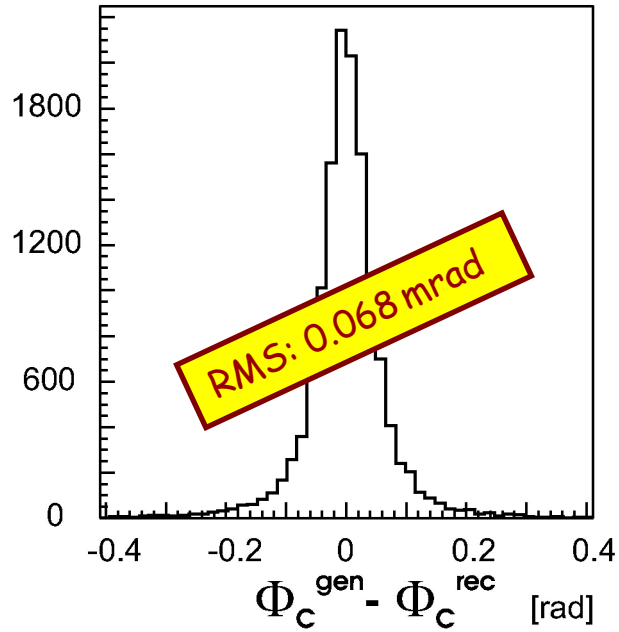


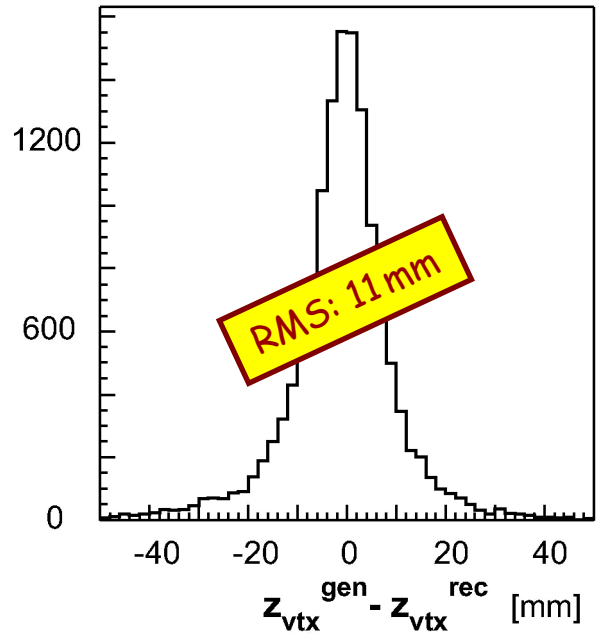


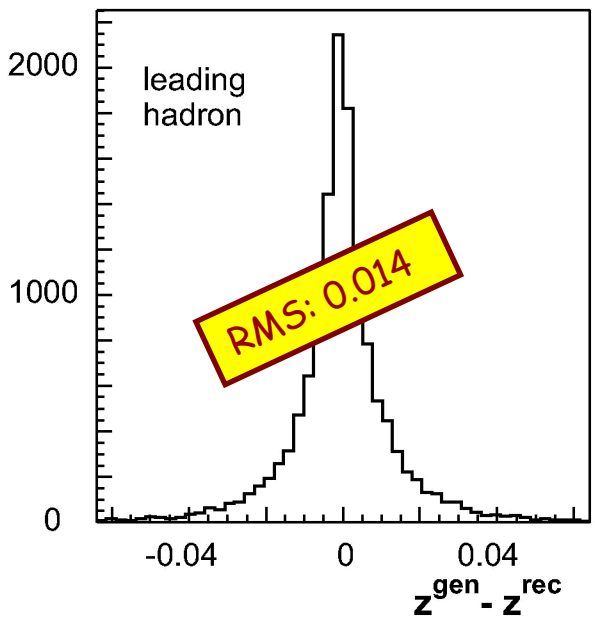


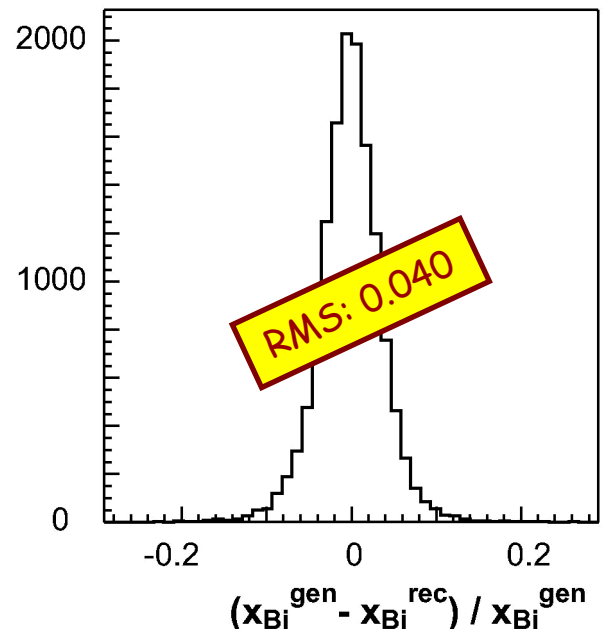
Monte Carlo studies (2)





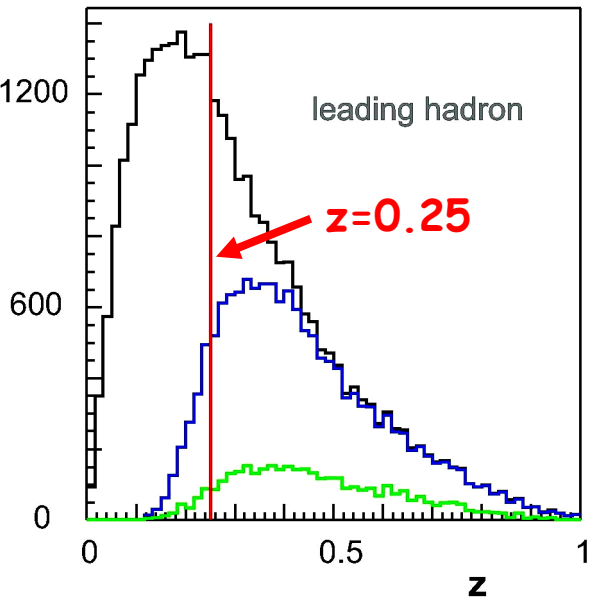


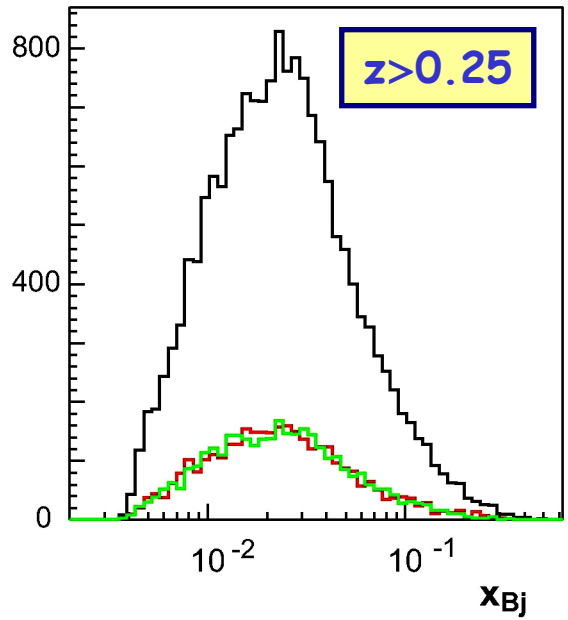


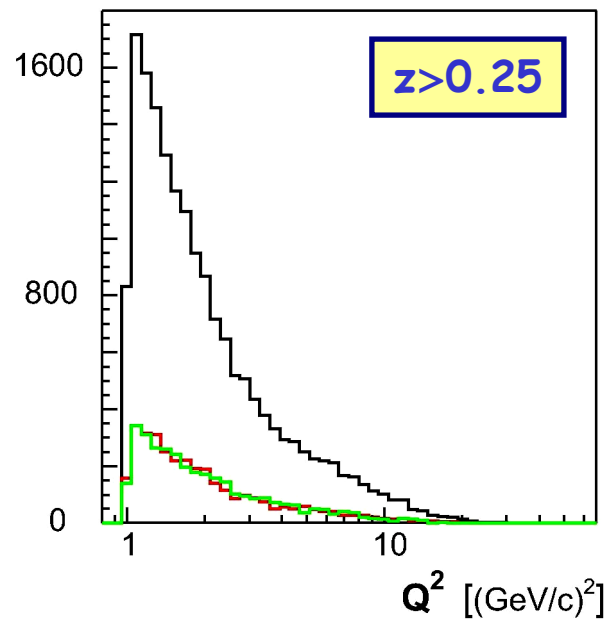


No signal dilution due to finite resolution!

Contamination of non-leading hadrons







all reconstructed hadrons

correctly reconstructed leading hadrons

correctly reconstructed leading hadron, but leading hadron is not π

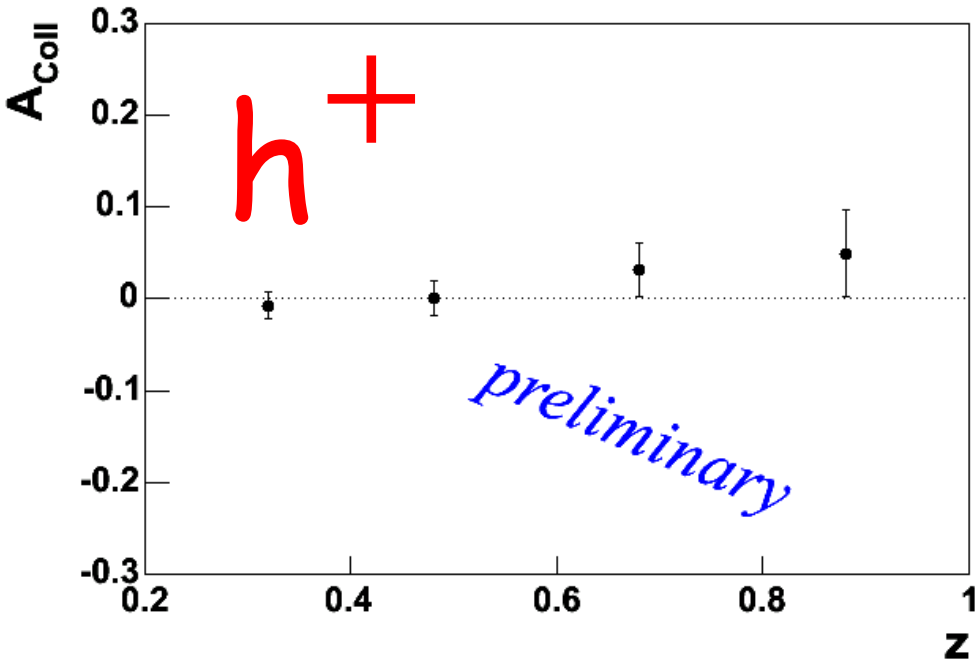
~20% of the final sample, mainly K and p

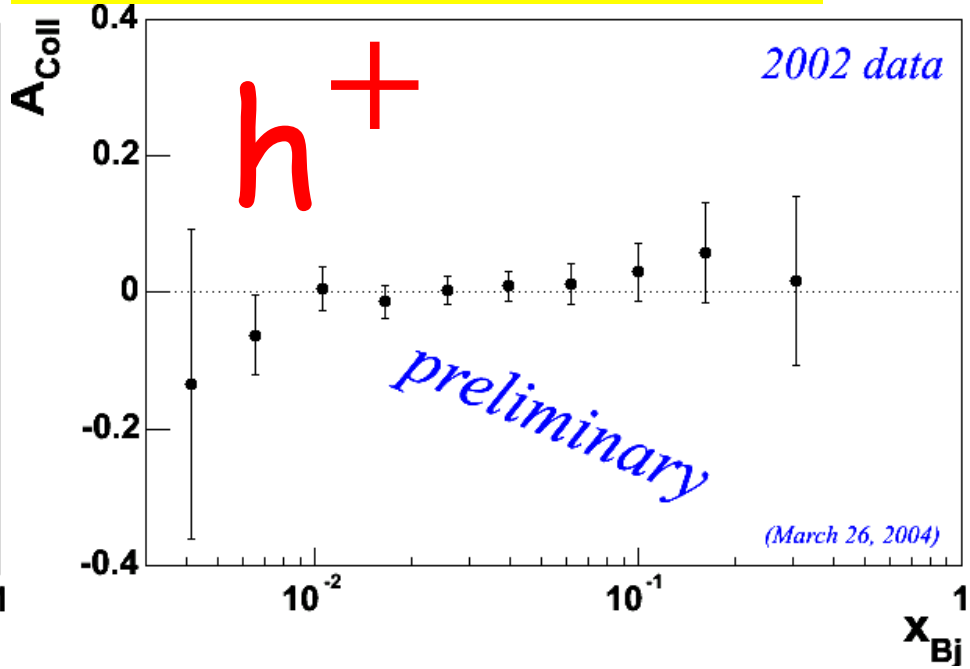
(RICH analysis not applied to data presented today)

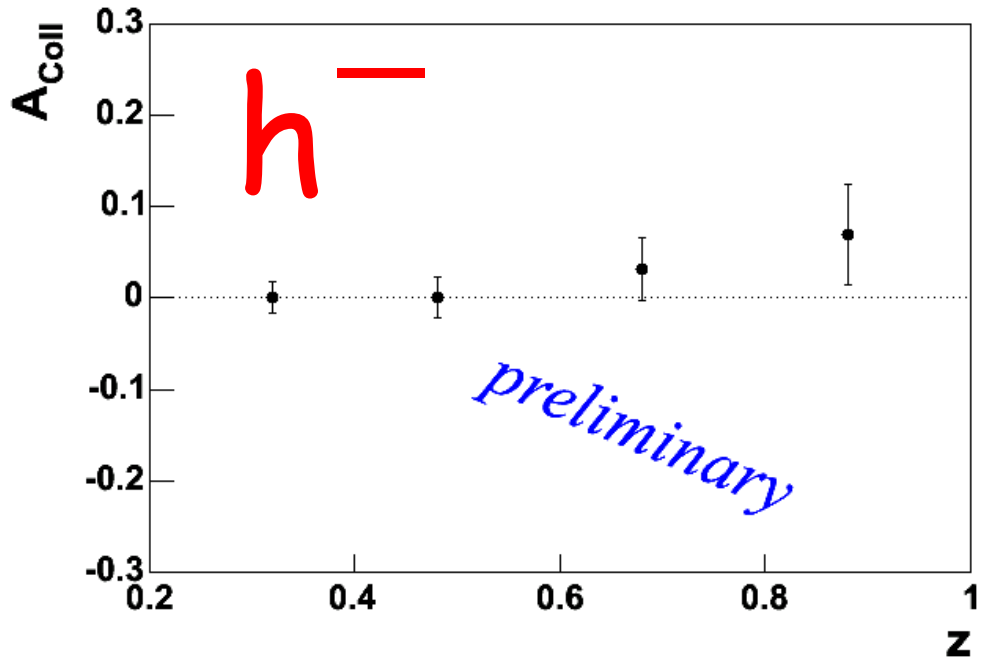
wrongly reconstructed leading hadrons

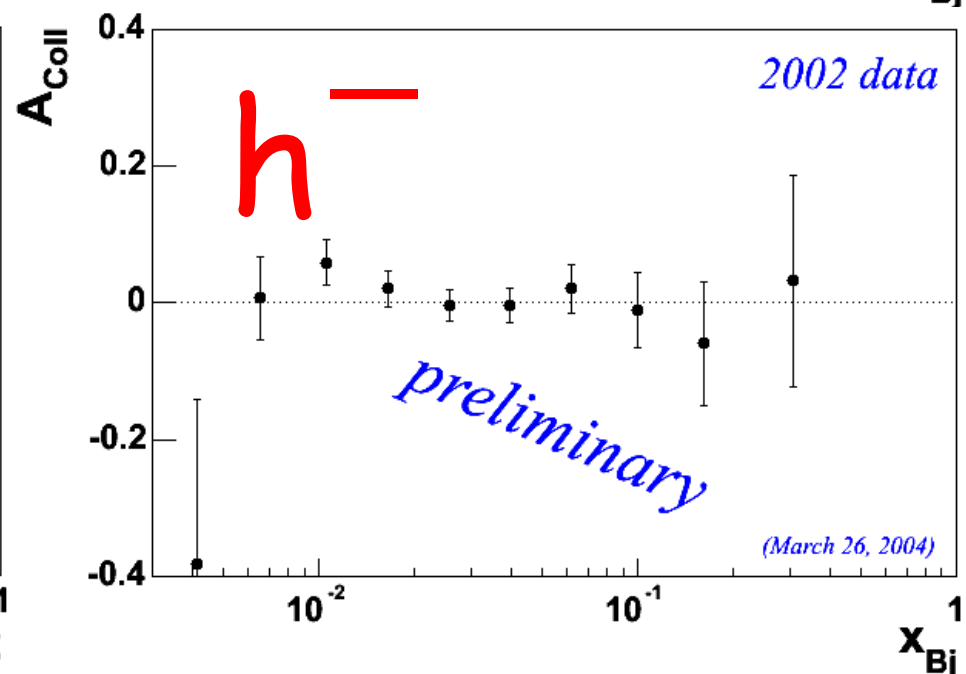
~20% of the final sample (probably smaller in the data because cuts on HCAL & $z_{lh}>1-\Sigma z_i$ not applied to MC events)

Collins-Asymmetrie (Deuteron)









Conclusion & Outlook

- Within statistical error the measured Collins asymmetries for leading hadrons from a Deuteron target are compatible with zero

- Including 2003 & 2004 data
  → sensitivity improvement by factor >2 expected

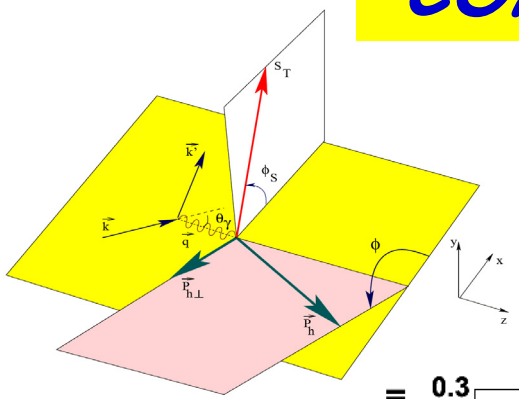
- Systematic investigations of Collins asymmetries for sub-leading hadrons still to be done

- Extract Collins asymmetries using independent quark polarimeters (Λ, leading hadron&next-to-leading hadron)

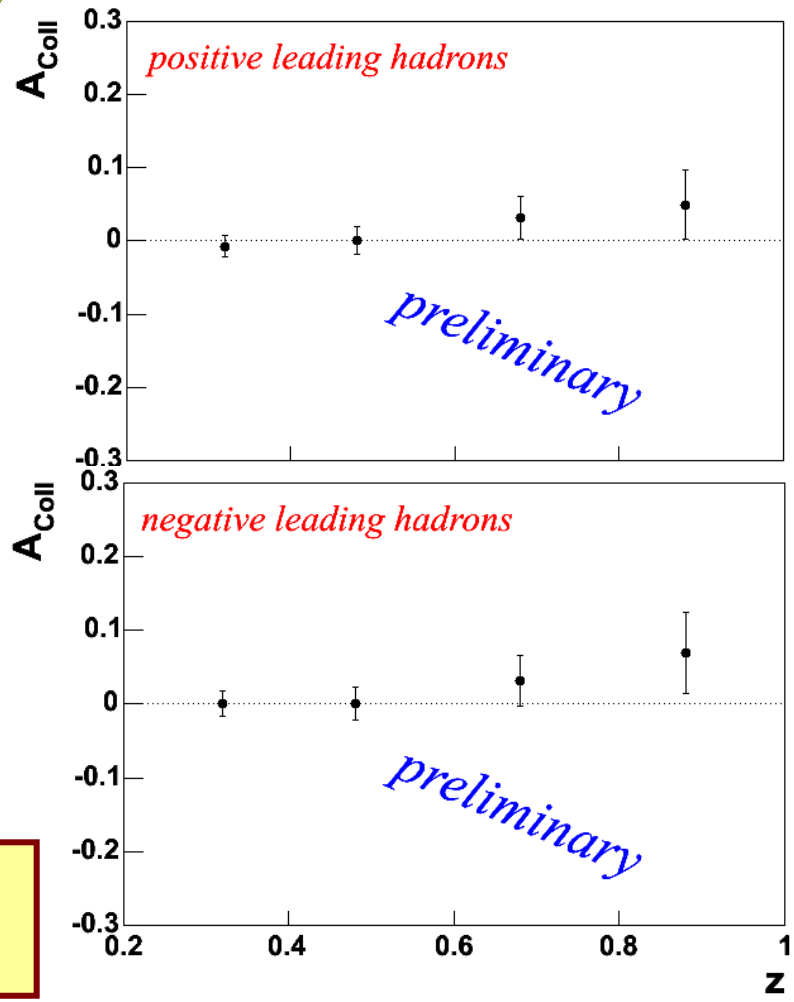
Many results on transverse spin physics can be expected from COMPASS in the next future

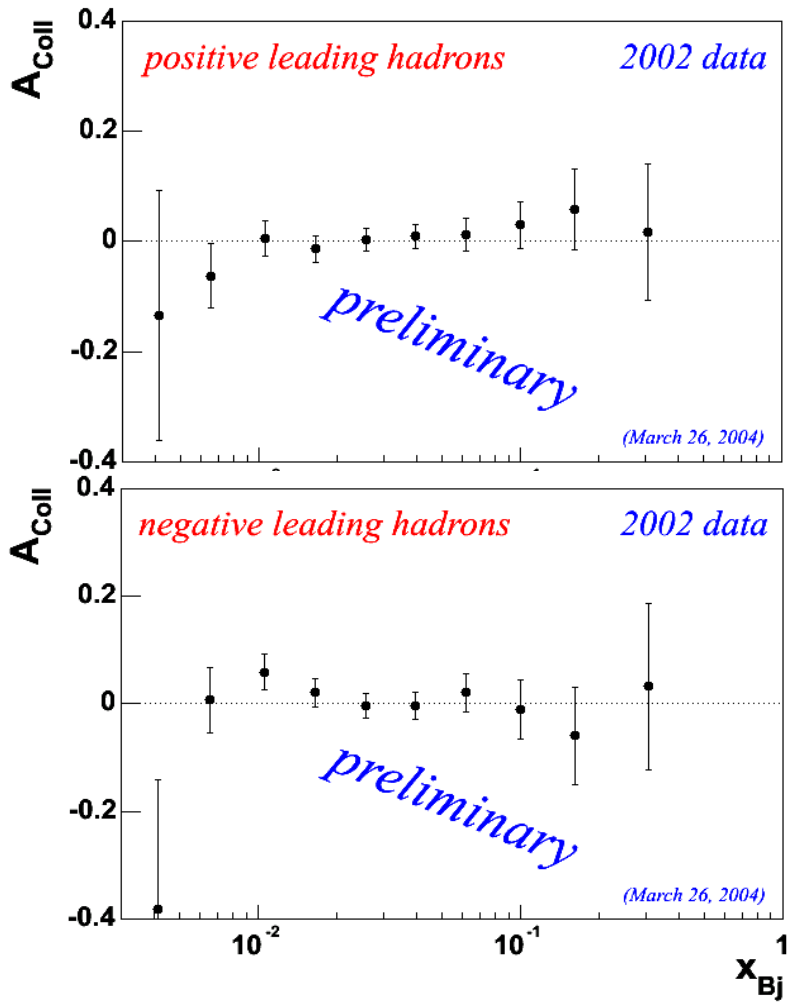
COMPASS: Collins-Asymmetrie

Horst Fischer
DIS2004



$$A_{Coll} \stackrel{c}{=} \frac{A_{UT}^{\sin\phi}}{D_{NN} \cdot f \cdot P} \propto \frac{\sum_q e_q^2 h_1^q(x,Q^2) \cdot H_1^{\perp(1)q}(z,Q^2)}{\sum_q e_q^2 f_1^q(x,Q^2) \cdot D_1^q(z,Q^2)}$$





polarized ^{6}LiD-Target